



24th COBEM - 2017



24th ABCM International Congress of Mechanical Engineering
December 3-8, 2017, Curitiba, PR, Brazil

COBEM-2017-1984

NICKEL-TITANIUM ELECTRODE FOR RADIOFREQUENCY HEPATIC ABLATION PROCEDURE

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Abstract. *The radiofrequency hepatic ablation consists in a minimally invasive procedure for treatment of cancerous tumors, realized by the Brazilian Unic Health System. Its execution is done by the insertion of an electrode in the tumor region and then the radiofrequency makes the carcinoma burn. This article presents the construction of a model of an umbrella type electrode with a temperature sensor, composed of three parts: handle, rods and sensor. The electrode modeling was made using the SOLIDWORKS® software, aiming to provide security and practicality while handling. There were executed initials tests of resistivity analysis of the rods NiTi material, by measuring the current after an applied tension. The 3D printed handle showed practicality with one hand handling. The observed behavior of the resistivity curve has shown an increase on the burning efficiency of the ablation process.*

Keywords: *Electrode, Ablation, Radiofrequency, Hepatocellular Carcinoma, Handle*

1. INTRODUCTION

The ablation by radiofrequency is a minimally invasive procedure used in small scale surgical procedures (Salas, *et al.*, 2011), applied to the treatment of hepatocellular carcinomas (HCC). This carcinoma attacks mainly men, being the sixth more prevalent neoplasia and the third greatest cause of death by cancer (Parkin, 2006).

For the treatment with ablation by radiofrequency to be efficient, it is required to have the diagnosis done quickly, because small HCC (up to 5 cm) are potentially curable. This procedure consists on insert an electrode up to the tumor location, so the heat of the electrode tip should be sufficient to burn the carcinoma completely, and necrotize the region (National Institute for Clinical Excellence, 2004). There was chosen an umbrella type electrode because it has long rods that can reach a larger burning area during the surgical procedure. This electrode was divided in three main parts: handle, rods and sensor. The handle is the part used for handle and control the electrode during the surgery and has the objective of facilitate the surgical procedure performance. The rods are formed by NiTi (Nickel-Titanium) welded to a tube, made of the same material, that has a temperature sensor isolated in its center, used to measure the real-time temperature of the tissue during the surgery, providing a better control during the burning of the carcinoma. This tube is fixed to a slider that slides over the handle body and open the rods at the electrode tip to conduct the radiofrequency to

the tissue. The resistivity analysis of the NiTi material, that has to be analyzed before and after the material pass through the molding process, is important to evaluate the efficiency of the burning process. The more linear the relation between the current and tension applied, the more efficient the ablation will be. In this way, this work aims to detail the construction of an easily handy electrode also with efficient burning capacity.

2. EXPERIMENTAL PROCEDURE (OR COMPUTATIONAL PROCEDURE)

To model the handle on the SOLIDWORKS® software, initially there were determined the dynamic and static friction coefficients related to the slider translation. Then, the object was 3D printed with Polylactic Acid (PLA).

The resistivity curve before the rods conformation was obtained by the measurement of tension and current parameters, using the Agilent® Semiconductor Device Analyzer, Model B1500A. The NiTi material has the format of a semi arch and has 13.6 cm of length. The test was made varying the tension between 0 V and 200 mV, in steps of 10 mV. The length of the characterized semi arch (the probes distance) was varied in the values of 1 cm, 3 cm, and 6.6 cm. The resistance of the equipment terminal wires was also measured, aiming to ensure an analysis of the NiTi semi arch itself alone.

3. RESULTS AND DISCUSSION

The Figure 1 presents an illustration of the modeled object on the SOLIDWORKS® software.

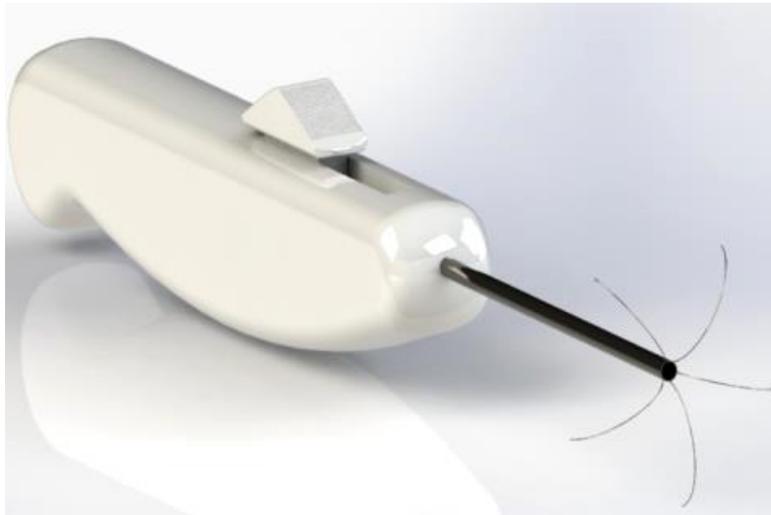


Figure 1. Final electrode model, made on the SOLIDWORKS® software.

The handle design was based on the format of a knife grip: an easily handy object, familiar to many people, making possible the use with one hand. The Figure 2 presents the graphic obtained on the tests with the probes spaced in 1 cm. The equipment has a limitation of current in 100 mA, therefore, only the region of the graphic before that point was analyzed.

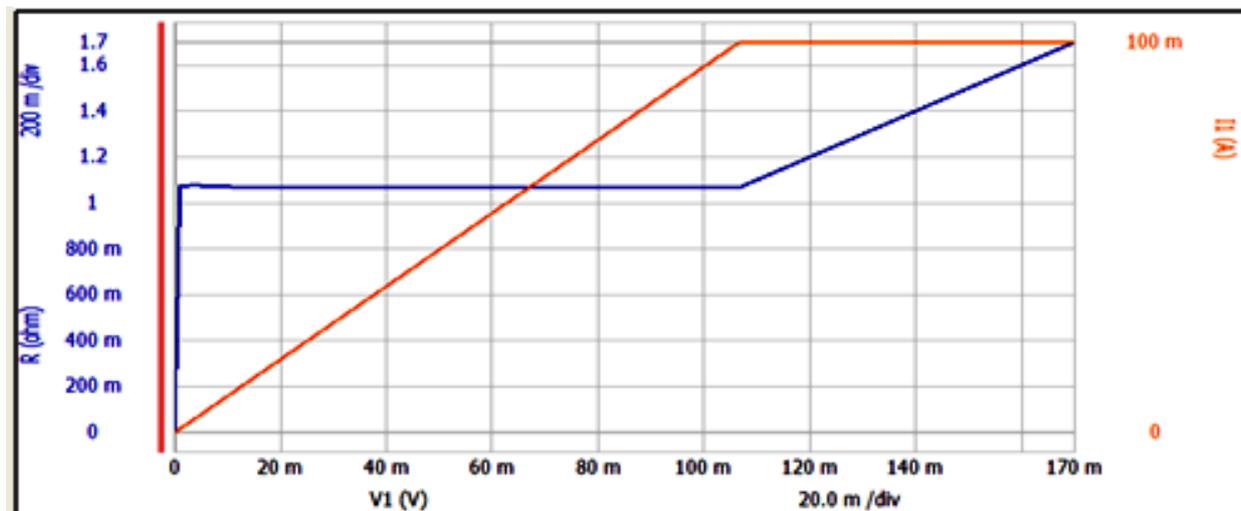


Figure 2. Resistivity curves of the NiTi rods. In orange: the measured current (I) in relation to the applied tension (V1), in blue: the correspondent resistance (R).

With the generated curve, is possible to identify that the NiTi material has a linear behavior, like ohmic elements. When the tension is raised in steps of 10 mV, and hence the current grows, it is noticed that the resistance keeps constant with a value around 1.075 Ω . The material shows a behavior similar to a wire, conducting current immediately after the application of a tension.

4. CONCLUSIONS

The purpose of this article was to describe and analyze the construction process of a national umbrella type electrode for hepatic ablation procedure. The 3D printed object has shown ease of handle, making possible its use with one hand. The details of smaller dimension were not printed with accuracy, therefore, it is intended to print the object with the verowhite material. There will exist hooks in the center of the tube to facilitate the passage and welding of the wires of the intern circuit.

The observed behavior of the rods resistivity curve implies on the increase of the burning efficiency during the ablation process. There will be made an analysis of the resistivity after the conformation, to verify changes on the material conductivity. Hence, the tests performed up to now were favorable to the continuity of the electrode construction.

5. REFERENCES

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6. ACKNOWLEDGEMENTS

We thank the Fundação de Apoio à Pesquisa – FAP/DF by encouraging participation in the event. The research team thanked also the entities that supported the project: Ministério da Saúde: Departamento do Complexo Industrial e Inovação em Saúde (DECIIS), Centro de Desenvolvimento Tecnológico (CDT/UnB), Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) and Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (Capes).

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